

## A new species of *Bolitoglossa* (Caudata: Plethodontidae) from the Cordillera de Mérida, Venezuela

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*Abstract.*—A new species of *Bolitoglossa* is described from cloud forests of the Macizo de Guaramacal in the northern range of the Cordillera de Mérida, Venezuela. The new species is most similar to *B. adspersa* and *B. savagei* from Colombia, and it seems to be only distantly related to the two other species of *Bolitoglossa* known from the Cordillera de Mérida. The new species is distinguished from Venezuelan congeners by its large size, moderately webbed hands and feet, and dorsal pale coloration.

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The speciose salamanders of the genus *Bolitoglossa* occur from northern Mexico to Bolivia and southern Brazil (Wake & Lynch 1976). Despite their wide distribution in South America, species diversity is considerably higher in Middle America, where in many localities several sympatric species can be found (Wake & Lynch 1976, Wake et al. 1992). This difference in diversity may be attributed to a relatively recent colonization of South America (late Miocene to late Pliocene) by bolitoglossine salamanders (Wake & Lynch 1976, Hanken & Wake 1982). However, salamanders in South America remain poorly studied relative to those in Middle America. Whereas extensive research on the taxonomy and systematics of Middle American salamanders has been carried out in the last 20 years (see works by Wake and collaborators in litt.), no major contribution to our knowledge of South American salamanders has been published since the pioneering works of Brame & Wake (1963, 1972).

In South America the genus *Bolitoglossa* attains its highest diversity in Colombia (Brame & Wake 1963, 1972), with 17 species currently recognized (Ruiz-Carranza et al. 1996, Acosta-Galvis & Restrepo 2001,

Lynch 2001). In Venezuela three species are known (Barrio & Fuentes 1999), all of which are associated with montane cloud forest habitat. These species are *B. borburata* from the Cordillera de la Costa, and *B. orestes* and *B. spongai*, two similar and presumably closely related species from the Cordillera de Mérida. Additionally, Brame & Wake (1963) referred a specimen from Mérida, Venezuela, to *B. savagei*, but this species has been excluded from Venezuela in taxonomic accounts of the amphibians of this country (e.g., La Marca 1997, Barrio 1998), because this record requires verification (Wake & Lynch 1976). In this paper we describe a new species of *Bolitoglossa* from cloud forests of the Macizo de Guaramacal, in the northeastern range of the Cordillera de Mérida, Venezuela. The Macizo de Guaramacal is a region suspected of a high number of endemics due to its particular physiographic isolation from the rest of the Cordillera de Mérida (García-Pérez 1999).

### Materials and Methods

The first specimen of the new species was discovered in a bromeliad in early 1995



Fig. 1. *Bolitoglossa guaramacalensis*. Holotype (MCNG A-2121) in life, SL = 69.4 mm.

by José Farreras, while conducting research on bromeliads of the genus *Guzmania* as a microhabitat of amphibians and reptiles in the National Park "General Cruz Carrillo" (Farreras 1995). Further field work in the region by one of us (JEGP) yielded three more specimens later that year. More recently, an additional specimen was collected by a group of students of the Universidad Nacional Experimental de los Llanos Occidentales "Ezequiel Zamora" (UNELLEZ) during a field trip to the region. The type-series is deposited at the Museo de Zoología, Museo de Ciencias Naturales de Guanare, Biocentro, UNELLEZ, Venezuela (MCNG). Comparative material was obtained from the Natural History Museum of the University of Kansas (KU), and the Natural History Museum of Los Angeles County (LACM), and is listed in the appendix.

All measurements were taken with a dial caliper to the nearest 0.1 mm with the aid of a dissecting scope. We used standard

measurements as defined by Brame & Wake (1963) and Campbell & Smith (1998). Color in life was recorded in the field and from color slides taken by JEGP that will be deposited in the MCNG collection, and includes variation from individuals that were not collected. For the limb osteology description the left fore- and hind limb of one specimen (MCNG A-2122) were removed and were cleared and double stained using standard procedures.

*Bolitoglossa guaramacalensis*, new species  
Fig. 1

*Bolitoglossa savagei*.—Brame and Wake, 1963:31 [In part, ZMB 25918].

*Bolitoglossa* sp.—García-Pérez, 1999:129.

*Holotype*.—MCNG A-2121, an adult female from Boconó-Guaramacal road, Quebrada El Pollo (9°13'N, 70°10'W), south slope of the Macizo de Guaramacal, 2400 m, Trujillo, Venezuela, collected by J. E. García-Pérez, 6 December 1995.

*Paratypes*.—All from Venezuela, Trujillo: MCNG A-2120, 2122, same data as the holotype. MCNG A-2123 from Boconó-Guaramacal road, north slope of the Macizo de Guaramacal, 2100 m, collected by J. A. Farreras on March 1995. MCNG A-2124, a subadult from Boconó-Batatal road, Laguna de Boconó, 2000 m, collected by a group of students of the field Ecology course of the UNELLEZ, 25 May 2001.

*Diagnosis*.—A large species of *Bolitoglossa* (maximum size: 69.4 mm standard length, SL), with moderately narrow head (SL 6.6–7.1 times head width), moderately high number of maxillary teeth (49–67 in adults) and having moderately webbed hands and feet. *Bolitoglossa guaramacalensis* differs from all other South American salamanders of the genus *Bolitoglossa* as follows: from the *altamazonica* group and *sima* group by its larger adult size (maximum SL within the *altamazonica* and *sima* group is 59.4 mm in a female specimen of *B. sima*), more maxillary teeth (>48 versus <49), and having moderately webbed hands and feet (versus extensively to completely webbed). It differs from the *medemi* group by having moderately webbed hand and feet (versus extensively webbed) and having proportionally shorter limbs (limb interval is 4 in *B. guaramacalensis* versus 3 or less in members of the *medemi* group). The new species differs from *B. lozanoi* and *B. phalarosoma* by having moderately webbed hands and feet (versus completely webbed) and more maxillary teeth in adults (32 in *B. lozanoi*; 30–51 in *B. phalarosoma*).

*Bolitoglossa guaramacalensis* is most similar to species in the *adspersa* group. Within this group *B. biseriata*, *B. borburata*, *B. capitana*, *B. hiemalis*, *B. nicefori*, *B. orestes*, *B. palmata*, *B. pandi*, and *B. spongai* all have extensively webbed hand and feet. *Bolitoglossa guaramacalensis* can be easily distinguished from all these species by having moderately webbed hands and feet. It further differs from *B. biseriata* by having a dark rather than a pale venter;

from *B. borburata* by having poorly-defined subdigital pads versus no subdigital pads; from *B. capitana* by being smaller (SL in *B. capitana* surpasses 80 mm); from *B. nicefori* by having the head slightly wider than the neck versus distinctly wider; from *B. pandi* by having an extensive pale versus mostly dark dorsal coloration; and from *B. hiemalis*, *B. orestes*, *B. palmata* and *B. spongai* by attaining a much larger adult size (SL of adult females >60 mm versus <55 mm). *Bolitoglossa guaramacalensis* differs from *B. hypacra* by having moderately webbed hands and feet (versus slightly webbed) and shorter limbs (limb interval 4 versus 2). It differs from *B. valleculla* by having a dark versus a mostly pale venter, and possessing poorly-defined subdigital pads versus pronounced subdigital pads. *Bolitoglossa guaramacalensis* is most similar to *B. adspersa* and *B. savagei*. It may be distinguished from *B. adspersa* by having a more extensive pale dorsal coloration, less developed subdigital pads, and lacking an evident postiliac gland versus having a well developed gland. The new species differs from *B. savagei* by having the first phalange of the fourth finger and of the fourth toe free from webbing versus not free from webbing. Additionally, *B. guaramacalensis* seems to be a larger species than *B. savagei*, given that the two adult female specimens in the type series of *B. guaramacalensis* are considerably larger (surpassing 60 mm in SL) than the largest known female specimen of *B. savagei* (55.1 mm in SL).

*Description of holotype*.—An adult female, 69.4 mm in standard length (SL); head narrow (SL 7.1 times greater than head width), slightly wider than neck; snout moderately short, rounded in dorsal view, slightly pointed in profile; nostrils small; nasolabial protuberances small; canthus rostralis indistinct, gently rounded; eyes moderately protuberant, barely visible in ventral view; horizontal distance across eye slightly longer than distance between anterior margin of eye and nostril; suborbital

groove well defined, extending for full length of orbit, following the curvature of eye; shallow postorbital groove extends posteriorly from eye, curves ventrad at level of posterior end of mandible, intersecting vertical nuchal groove; nuchal groove poorly defined ventrally, 3.8 mm anterior to well defined gular fold; vomerine teeth 32, arranged in single arched row on each side, narrowly separated from parasphenoid tooth patch; maxillary teeth 67, small, extending posteriorly to a point about three fourths of the eye; premaxillary teeth 7, small; costal grooves 13; post iliac gland not evident; limbs of moderate length, moderately slender, but shanks swell considerably distally; limb interval 4; SL 5.1 times right fore limb; SL 4.7 times right hind limb; hands and feet somewhat flattened, with incomplete webbing; digits with rounded tips, extending well beyond webbing, except for first digit, which extends slightly from webbing; poorly-defined subterminal pads on fingers and toes; fingers in order of decreasing length are: III, IV, II, I; toes in order of decreasing length are: III, IV, V, II, I; tail slightly compressed laterally, moderately constricted at base.

In preservative (alcohol after formalin) the dorsal ground color is mostly cream with small dark gray spots and dark gray mottling. There are two poorly defined dark gray dorsolateral stripes that extend from the level of the fourth costal groove to the level of the hindlimbs. The upper halves of the lateral regions of the trunk are paler than the dorsum but with more small dark spots. The lower lateral half of the trunk is grayish brown with cream mottling. The dorsum of the head is grayish brown with small black and pale spots, except for paratoid glands and neck which are cream. The nasolabial protuberances are whitish cream. The ventral surface of the head and throat is grayish brown with small cream spots. The venter is grayish brown with poorly defined, irregular, pale longitudinal streaks. The dorsal surface of the tail is cream and

the lateral and ventral regions of the tail are grayish brown with pale mottling.

*Measurements.*—SL 69.4 mm, tail length (TL) 63.3 mm, head length (HL) 14.6 mm, head width (HW) 9.8 mm, head depth 5.4 mm, distance from anterior edge of eye to end of snout 2.9 mm, eyelid length 3.6 mm, eyelid width 1.8 mm, interorbital distance 2.9 mm, distance between center of external nares 3.1 mm, axilla-groin 38.3 mm, depth of tail base 5.8 mm, width of tail base 5.2 mm.

*Variation.*—There are three adults in the type series including the holotype. MCNG A-2120 is an adult male (SL 48.3 mm, TL 54.9 mm) with a well-developed subcircular mental gland. The SL is 6.6 times greater than HW. There are 49 maxillary, no premaxillary, and 20 vomerine teeth. MCNG A-2122 is an adult female (SL 60.4 mm, TL 58.1 mm) and the only specimen to have distinct, well-developed, paratoid glands. The SL is 7.0 times greater than HW. There are 53 maxillary teeth, 3 premaxillary teeth, and 23 vomerine teeth. Measurements and counts for two subadults (MCNG A-2123–2124) are: SL 40.5 mm, TL 43.4 mm, HW 6.0 mm, 34 maxillary teeth, no premaxillary teeth, 19 vomerine teeth, for MCNG A-2123; and SL 40.3 mm, TL 32.7 mm, HW 5.9 mm, 38 maxillary teeth, 3 premaxillary, 16 vomerine teeth, for MCNG A-2124.

*Color in life.*—The dorsum is heavily pigmented with pale coloration which varies from reddish-orange to pale yellow. The pale coloration appears as large irregular blotches or longitudinal streaks with gray suffusions, and invades the dorsum of the head and the tail to some extent. Several individuals possess a dark discontinuous dorsolateral stripe. The lateral surfaces of the trunk and tail are dark brown or dark olive with some pale mottling. The venter is darker than the lateral color and usually has some inconspicuous cream marks.

*Limb osteology.*—Hands and feet have well developed digits (Fig. 2). The phalangeal formula is 1,2,3,2 for the hand and

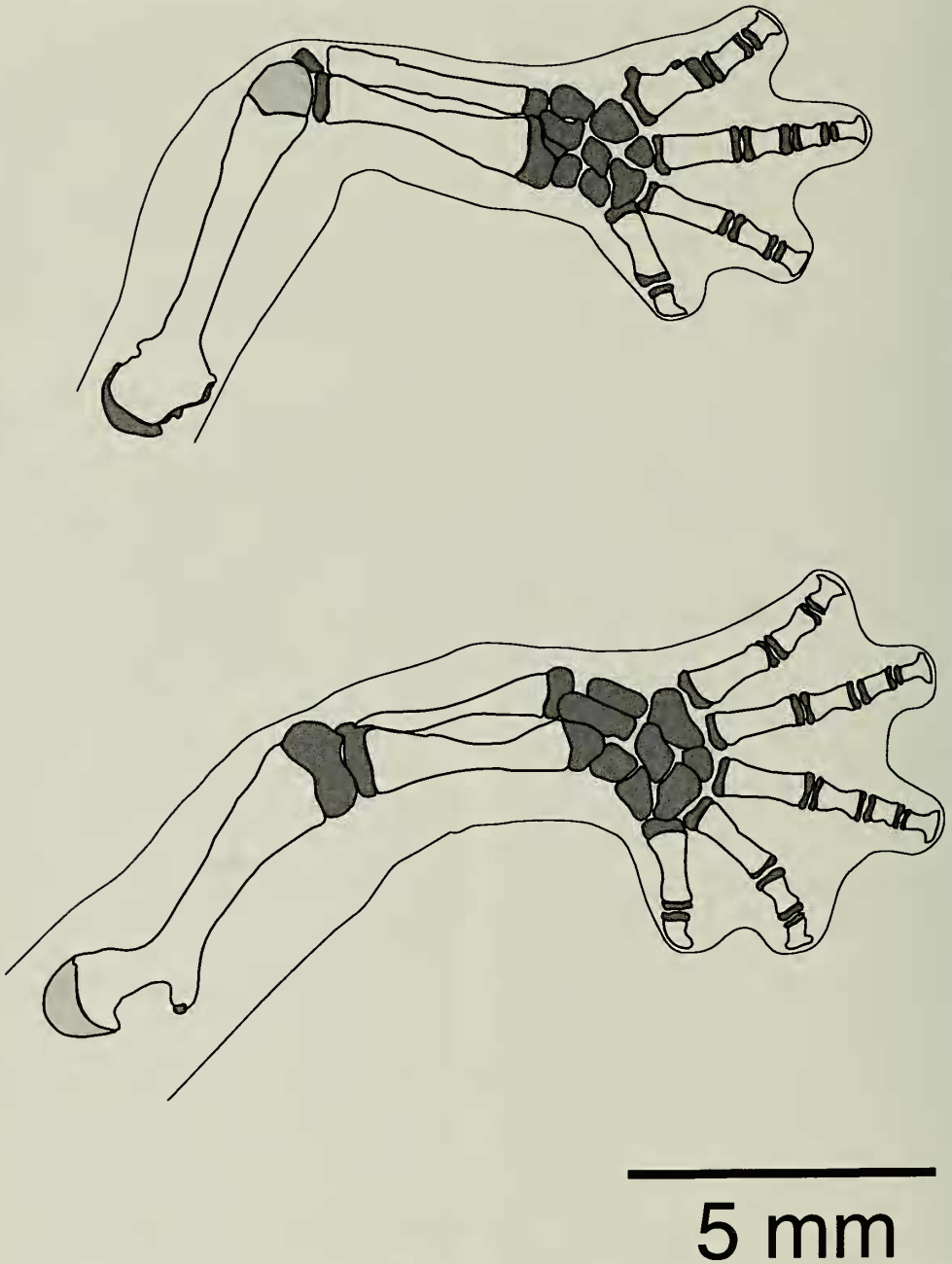


Fig. 2. *Bolitoglossa guaramacalensis*. Dorsal view of the cleared and stained left fore- (upper) and hindlimb (lower) of MCNG A-2122.

1,2,3,3,2 for the foot. The distal ends of the terminal phalanges are greatly expanded laterally ("T-shape"), except for the first finger and toe in which the lateral expansion is reduced on the side facing the body.

There are eight carpal elements and seven tarsal elements. The basal tarsals of the fourth and fifth toes are fused. No tibial spur is present and the tibial crest is very small.

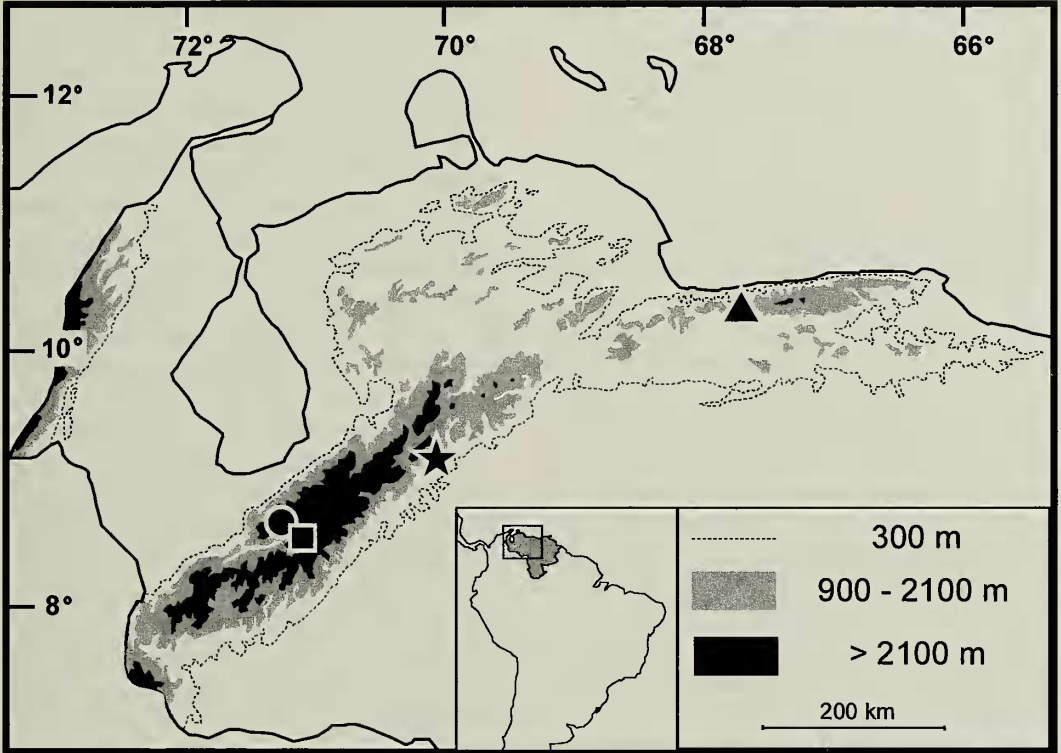


Fig. 3. Map of northwestern Venezuela showing the distribution of *Bolitoglossa borburata* (triangle), *B. guaramacalensis* sp. nov. (star), *B. orestes* (square), and *B. spongai* (circle).

*Etymology.*—The specific name is derived from the type locality *guaramacal* and the Latin suffix *-ensis*, denoting place.

*Distribution and ecology.*—This species is known only from cloud forest, at 1900–2400 m, on the north and south slopes of the Macizo de Guaramacal, which is located in the northeastern range of the Cordillera de Mérida (Fig. 3). Part of this mountain range, including the type locality, is protected by the national park system of Venezuela, as the Parque Nacional “General Cruz Carrillo”. The holotype and two of the paratypes (MCNG A-2120, 2122) were collected under rocks a few meters from a mountain stream on the south slope. One specimen (MCNG A-2123) was collected on the north slope inside an epiphytic bromeliad of the genus *Guzmania*, located two meters above ground. MCNG A-2124 was also collected on the north slope; it was

found under a rock in an area which had been clearcut. One of us (JEGP) did extensive fieldwork throughout 1996 and 1997 on the south slope of the Macizo de Guaramacal, studying local amphibian declines, and found many individuals of *Bolitoglossa guaramacalensis* throughout the year. Most of them were observed under rocks, usually located close to streams; only a few were found in bromeliads. Some individuals had regenerated tails, indicating the potential importance of tail autotomy as an antipredator behavior in this species of salamander. García-Pérez (1999) provided a discussion of the amphibians and reptiles of the region. For a detailed description of the region refer to Cuello (1999).

#### Discussion

*Bolitoglossa guaramacalensis* is the fourth species of the genus known from Ve-

nezuela and the third from the Cordillera de Mérida. This species is tentatively assigned to the *adpersa* group. It is most similar to and may be related to a series of species, including *B. adpersa*, *B. borburata*, *B. savagei*, *B. taylora* and *B. valleculea*, which appear to form a clade based on size, proportions, and number and arrangement of vomerine teeth (Brame & Wake 1963, Wake et al. 1970). In the original description of *B. savagei* from the Sierra Nevada de Santa Marta, Colombia, Brame & Wake (1963) reported a single specimen (ZMB 25918) referred to *B. savagei* from the vicinity of the city of Mérida, which lies in the southwestern range of the Cordillera de Mérida (this specimen is deposited in the Zoologisches Museum of Berlin and could not be examined by us). Wake & Lynch (1976) later added that this record required verification. Based on geographic barriers and distance, as well as faunal relationships, it seems very unlikely that *B. savagei* occurs in the Cordillera de Mérida. We herein refer the Venezuelan record of *B. savagei* to *B. guaramacalensis*, because these two species are morphologically very similar, and the measurements given by Brame & Wake (1963) for the specimen in question fall within the variation of *B. guaramacalensis*. The only two species of salamander reported near the city of Mérida are *B. orestes* and *B. spongai*, but we believe that it is possible that the locality data for the ZMB specimen is the shipping point and not the collecting locality, which was a common mistake in earlier times.

The two other species of *Bolitoglossa* from the Cordillera de Mérida, *B. orestes* and *B. spongai*, are similar to each other and presumably closely related. These species share a small size, short snout, and similar foot shape. Brame & Wake (1962) allocated *B. orestes* and *B. palmata* from Ecuador to the *palmata* group, but later dissolved the group and assigned these species to different subgroups of the *adpersa* group (Brame & Wake 1972). However, they did not provide an explanation for this

rearrangement. Recently Lynch (2001) described *B. hiemalis* from Colombia and allocated this species to the *palmata* group as defined earlier by Brame & Wake (1962), disregarding the most recent grouping arrangement (Brame & Wake 1972).

The groupings used in taxonomic studies of *Bolitoglossa* from South America remain poorly defined and are mostly based on phenetic criteria, as a result of the poor understanding of the phylogenetic relationships within the genus. Additionally, it is likely that many more undescribed species of *Bolitoglossa* remain to be discovered in South America, mainly in the northern Andes. The Andean cloud forests and páramos that constitute the habitat of many species of *Bolitoglossa* have undergone a complex history of alternating glacials and interglacials during the Pleistocene (van der Hammen & Cleef 1986). This phenomenon has resulted in alternating periods of dispersal and vicariance of the high Andean biota, and very likely accounts for the high beta diversity observed in this region (Duellman 1982). Therefore, it is expected that species of *Bolitoglossa* have a geographical pattern of endemism similar to other high Andean amphibians, such as *Atelopus*, *Colostethus* and *Eleutherodactylus*.

The higher elevations (>1700 m) of the Macizo de Guaramacal have been isolated from the rest of Cordillera de Mérida since at least the last glacial of the Pleistocene by the deep dry valley of the Boconó River (García-Pérez 1999). Furthermore, the region has been regarded as a Pleistocene refuge for many Andean plant groups, with a considerable number of endemics (Steyermark 1979, Cuatrecasas 1986, Stergios 1999). Given this historic isolation, it is possible that *B. guaramacalensis* is endemic to the Macizo de Guaramacal.

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## Appendix

## Specimens examined

*Bolitoglossa adspersa*: COLOMBIA. Boyacá: KU 169974–169976, 170035–170037. Cundinamarca: KU 110380, 124670–124673, 132637, 132638, 169974–169976, 170035–170037.

*Bolitoglossa biseriata*: COLOMBIA. Valle: KU 169967–169969.

*Bolitoglossa borburata*: VENEZUELA. Aragua: KU 185774, 185775.

*Bolitoglossa hypacra*: COLOMBIA: Antioquia: LACM 64639, 64643, 64656, 64658, 64660, 64661,

64663, 65664, 64670, 64681, 64682, 64699, 64714, 64719, 64721, 64723, 64726, 64727, 64737, 64738, 64747, 64750, 64751, 64758.

*Bolitoglossa savagei*: COLOMBIA: Magdalena: LACM 114406, 114407.

*Bolitoglossa nicefori*: COLOMBIA: Santander: LACM 64764–64780.

*Bolitoglossa valleculea*: COLOMBIA: Antioquia: KU 203862, LACM 42284–42286, 42291, 64636, 135410, 135499.

*Bolitoglossa walkeri*: COLOMBIA: Cauca: KU: 169973.